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SOUTHWEST FISHERIES SCIENCE CENTER

NATIONAL MARINE FISHERIES SERVICE

SOUTHWEST FISHERIES SCIENCE CENTER

P.O. BOX 271

LA JOLLA, CA 92038

APRIL 1994

REVISED AND EDITED FIELD NOTES
1993 DOLPHIN-TUNA TRACKING STUDY
6 NOVEMBER 1993 - 5 DECEMBER 1993

By

Wesley A. Armstrong

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National Marine Fisheries Service
2570 Dole Street
Honolulu, Hawaii

ADMINISTRATIVE REPORT LJ-94-06

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WESLEY A. ARMSTRONG

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APRIL, 1994

CONTENTS

	Page
LIST OF FIGURES	ii
LIST OF TABLES	ii
ABSTRACT	1
INTRODUCTION	1
ITINERARY	2
RESULTS	3
ACKNOWLEDGEMENTS	3
REVISED AND EDITED FIELD NOTES 1993 DOLPHIN-TUNA TRACKING STUDY	4
APPENDIX 1	38

LIST OF FIGURES

FIGURE 1 MAP OF THE 1991 EXPLORATION-TECHNOLOGY TRAILING STUDY AREA 10

LIST OF TABLES

TABLE 1 SUMMARY OF DATA MADE DURING THE 1991 EXPLORATION-TECHNOLOGY TRAILING AND TEACHING STUDY 10-11

TABLE 2 SUMMARY OF CETACEAN ENCOUNTERS 10-20

TABLE 3 PROSPECTIVE BIRDS' SAMPLE DATA FROM THE 1991 EXPLORATION-TECHNOLOGY TRAILING STUDY AROUND THE ALASKA SHIP WRECKAGE 10-27

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BY
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ABSTRACT

The Department of Commerce's National Marine Fisheries Service (NMFS) entered into an agreement to facilitate a second year of cooperative research between NMFS and the Inter-American Tropical Tuna Commission (IATTC) for the fall of 1993. An Inter-Agency Agreement was written which provided the means for a transfer of funds from NMFS to the Department of State. The Department of State subsequently provided these funds to the IATTC. Thirty days of ship time were available aboard the NOAA Ship *McARTHUR* between 6 November 1993 - 5 December 1993. The *CONVEMAR*, a Mexican tuna purse-seiner was chartered by the IATTC for the study. The primary objective of the project was to study the relationship between yellowfin tuna (*Thunnus albacares*) and spotted dolphins (*Stenella attenuata*) by capturing, tagging, and simultaneously tracking the dolphins and tuna. Both tuna and dolphin tags could be equipped with pressure sensing devices which would transmit (tuna) or store (dolphin) dive data and permit analysis of vertical distribution of each species. Eighteen sets were made on dolphins during the 30-day Dolphin-Tuna Tracking Cruise. Five spotted dolphins were captured and tagged with radio-transmitter packages during five sets. All of the tagged dolphins were successfully tracked. Four of the radio-transmitter packages attached to dolphins were integrated with time-depth recorder (TDR) units. Three of the four TDR packages were recovered from recaptured dolphins. The dive data down-loaded from the TDR's ranged from 18 hours to over four days in duration. A total of six yellowfin tuna were tagged during three sets. Three of the tagged tunas were tracked with depth-sensitive transmitters. The three tuna tracks were thirty-one, one, and eight hours in duration. This report contains the edited and revised field notes collected during the study.

INTRODUCTION:

The Department of Commerce's National Marine Fisheries Service (NMFS) entered into an agreement to facilitate a second year of cooperative research between NMFS and the Inter-American Tropical Tuna Commission (IATTC) for the fall of 1993. The scientific personnel who participated in the study are listed in APPENDIX 1. The project was a simultaneous tracking study of spotted dolphins and yellowfin tuna in the waters off Central America. A preliminary tracking study (1992 Dolphin-Safe research cruise) was conducted in November-December 1992 to study the tuna-dolphin association. The researchers successfully tracked 6 dolphins, but were unsuccessful in tracking the tuna captured in

association with the dolphin schools. Experience gained by NMFS and IATTC scientists, and NOAA ship personnel during the 1992 Dolphin-Safe cruise certainly contributed to the successes achieved during the 1993 research effort.

The NOAA Ship *McARTHUR* and the Mexican commercial tuna purse-seine vessel, *CONVEMAR* participated in the study. The study was conducted by the IATTC in cooperation with the NMFS, the University of Hawaii (UH), with participation by biologists from the Universidad Nacional de Costa Rica (UNCR), the Programa Nacional para el Aprovechamiento del Atún y Protección de los Delfines (PNAAPD).

ITINERARY:

- ▶ 6 November 1993 *McARTHUR* depart Mazatlán, Mexico
CONVEMAR depart Ensenada, Mexico
- ▶ 1 December 1993 *CONVEMAR* arrive Manzanillo, Mexico
- ▶ 5 December 1993 *McARTHUR* arrive San Diego, CA USA

Thirty days of ship time were available aboard the NOAA Ship *McARTHUR* between 6 November 1993 - 5 December 1993. The *CONVEMAR*, a 1,200 gross-ton, Mexican tuna purse-seiner equipped with a helicopter was chartered by the IATTC commencing on 6 November 1993. The primary function of the *CONVEMAR* was to support the simultaneous tuna-dolphin tracking study by locating, capturing, and releasing spotted dolphins and yellowfin tuna for subsequent tracking by the *McARTHUR*. The proposed area of operation was bounded by the following coordinates (FIGURE 1):

- ▶ 32°30'N 117°00'W United States/Mexican boarder
- ▶ 5°00'N 117°00'W
- ▶ 5°00'N 81°00'W
- ▶ 7°12'N 77°55'W The coastal Panamanian/Columbian border

The primary objective of the project was to study the relationship between yellowfin tuna (*Thunnus albacares*) and spotted dolphins (*Stenella attenuata*) by capturing, tagging, and simultaneously tracking the dolphins and tuna. Both tuna and dolphin tags could be equipped with pressure sensing devices which would transmit (tuna) or store (dolphin) dive data and permit analysis of vertical distribution of each species. The value of data collected by this approach are two-fold. Understanding tuna and dolphin movements and interactions in conjunction with food habits studies being conducted by IATTC and NMFS should help to establish the dynamics and duration of the tuna-dolphin bond and the degree that it is food based. From a management perspective, it may be possible to determine if the bond weakens at particular times which may make the tuna vulnerable to dolphin-safe fishing methods.

RESULTS:

Eighteen sets were made on dolphins during the 30-day Dolphin-Tuna Tracking Cruise (Table 1). Five spotted dolphins were captured and tagged with radio-transmitter packages during five sets (4, 7, 11, 16, and 17). All of the tagged dolphins were successfully tracked. Four radio-transmitter packages (attached to dolphins D-7 through D-10) were integrated with time-depth recorder (TDR) units. The TDRs measured and stored the depth of tagged dolphins every 5 seconds. One of the tagged dolphins (D-11) was outfitted with a standard radio-transmitter package. This device transmits only data about surface position of the dolphin. In order to down-load data from the TDR's, it was necessary to recapture tagged dolphins and remove the radio tag from the dorsal fin. Three of the four TDR packages were recovered from recaptured dolphins. The dive data down-loaded from the TDR's ranged from 18 hours to over four days in duration.

A total of six yellowfin tuna (T1-T6) were tagged during three sets (7, 11, and 17). Three types of transmitters were attached to tuna. One type of tuna tag (V3: range 0.5 - 0.75nm) provided horizontal movement information exclusively. The two other types of tuna tags (V7P: range 0.75 - 1.0 nm, and V3P: range 0.5 - .075 nm) transmitted ambient water pressure to monitor the animals' swimming depth in addition to its location. Three of the tagged tunas (T1 and T3: V7P tags, and T5: V3P tag) were tracked. Two of the tagged tunas (T1 and T3) were released simultaneously with a dolphin school during the backdown procedure and one tagged tuna (T5) was released after backdown by releasing the bow ortza of the seine. Three tuna T2, T4, and T6) were tagged with V3 tags but were not tracked. The three tuna tracks were thirty-one, one, and eight hours in duration.

Marine mammal watches were conducted by scientific field party members aboard the *McARTHUR* during daylight hours throughout the cruise. A total of 86 cetacean sightings were recorded (Table 2). Biopsy samples were collected as an ancillary project from cetaceans that rode the bow wave of the research vessel. A low-powered crossbow was used to obtain a small piece of skin (Table 3). The samples will be used by scientists at SWFSC's genetics lab to determine mitochondrial DNA sequence variation within and between populations of small cetaceans.

The text that follows is the edited and revised field notes collected by NMFS Fisheries Biologist, Wesley Armstrong during the 1993 Dolphin-Tuna Tracking Study which was conducted from 6 November 1993 - 5 December 1993.

ACKNOWLEDGEMENTS

Special thanks to Dave Peterson and Benjamin Cervantes, the commanding officer of the *McARTHUR* and the captain of the *CONVEMAR* for their patience, and seamanship that permitted the research to be conducted in a safe and efficient manner. The personnel working on both vessels were required to work long days and nights throughout the cruise. The members of the scientific field party appreciated their tireless efforts. Thank-you to Michael Scott for maintaining order in often chaotic situations, and for providing a comfortable work environment for the NMFS scientists participating in the project.

Charles Oliver and Liz Edwards were responsible for much of the tedious behind the scenes efforts required to get a large scale effort such as this off the ground. Charles Oliver, Liz Edwards, and Al Myrick reviewed the materials and offered useful suggestions and guidance.

**REVISED AND EDITED FIELD NOTES
1993 DOLPHIN-TUNA TRACKING STUDY
6 NOVEMBER 1993 - 5 DECEMBER 1993**

6 November 1993

Daily Activities:

The NOAA Ship *McARTHUR* departed from Mazatlán, Mexico at 17:30 hr. The vessel travelled to an area where sea conditions were forecasted to be calm approximately 30 miles northeast of Cabo San Lucas. The ship's proposed operations for the day were to practice deployment and recovery of tracking launches and test the radio and sonic-tracking gear while waiting for the chartered purse-seine vessel, *CONVEMAR* to arrive at the rendezvous position.

7 November 1993

(Noon Position: 23°20'N and 109°14'W)

Daily Activities:

The ship's position was 23°18'N and 108°40'W at 06:00 hr. The primary sonic tracking vessel (AR-4) was deployed at 10:00 hr to practice deployment and recovery, and radio/sonic tracking procedures. Michael Scott (Chief Scientist) instructed scientific field party members in the use of radio tracking gear and data recording requirements during actual dolphin-tracking operations. Personnel aboard the AR-4 attached a tuna sonic-transmitter tag to an orange balloon float and put it in the water to test the range of the transmitter. A dolphin radio-transmitter tag was carried aboard the AR-4 so personnel aboard the *McARTHUR* could practice using the dolphin tracking gear installed aboard the *McARTHUR*.

An all-hands meeting was called aboard the *McARTHUR* following the test of the tracking gear and the recovery of the AR-4. Scott presented results from the 1992 Dolphin-Safe Cruise and explained the primary objectives of the cruise. Holland provided the crew with an overview of the goals for the tuna tracking portion of the project and played a video tape that demonstrated successful tagging and tracking operations he had conducted in Hawaii. The *McARTHUR* anchored on a shoal at 18:00 hr so vessel personnel could enjoy some evening fishing.

8 November 1993

(Noon position: 23°02'N and 109°31'W)

Daily Activities:

The ship steamed to Cabo Falso, approximately 10 miles northwest of Cabo San Lucas to attempt to find a lee from a building northeasterly wind. A lee was needed to practice

additional tracking launch deployment and recovery and to further test dolphin and tuna tracking gear before the rendezvous with the *CONVEMAR*. The prevailing winds shifted to the west as the ship rounded Cabo San Lucas. The deterioration of sea surface conditions made small boat operations unfeasible. The ship anchored off of Cabo Falso for the afternoon and then slowly steamed to the rendezvous position with the *CONVEMAR*. I repaired a leak in the dolphin tagging team's raft during the afternoon transit.

9 November 1993

(Noon position: 21°48'N and 108°46'W)

Daily Activities:

The ship's position was 22°03'N and 109°02'W at 06:00 hr. Most of the day was spent in transit to the rendezvous position. Crewmen aboard the *CONVEMAR* located a school of dolphins that were carrying tuna and made a set (Set No. 1). They did not catch any fish (skunk set). A new rendezvous position was designated by Scott and transmitted to the purse-seine vessel by radio.

10 November 1993

(Noon Position: 19°54'W and 107°03'W)

Daily Activities:

The ships position was 20°27'N and 107°07'W at 06:00 hr. The *McARTHUR* rendezvoused with the *CONVEMAR* at 06:20 hr. The *CONVEMAR*'s fishing captain and the IATTC field party leader travelled to the *McARTHUR* by speedboat for an operations meeting. The meeting was conducted in the wardroom of the *McARTHUR*. A list of the personnel who attended the meeting follows.

NAME	POSITION	ORGANIZATION
Dr. Michael D. Scott	Chief Scientist	IATTC
Dr. Robert Olson	Scientist	IATTC
Dr. Susan Chivers	Scientist	NMFS
	<i>(NMFS Field Party Leader)</i>	
Dr. Kim Holland	Scientist	University of Hawaii
Dave Bratten	Scientist	IATTC
	<i>(IATTC Field Party Leader)</i>	
Wesley Armstrong	Scientist	NMFS
Marco García	Scientist	IATTC
Howard Rhinehart	Veterinary Technician	IATTC
Commander D. Peterson	Commanding Officer	NOAA CORPS
Lt. John Herring	Field Operations	NOAA CORPS
Benjamin Cervantes	Fishing Captain	<i>CONVEMAR</i>

Discussion:

It was determined that both vessels would start searching for tuna-dolphin schools at sunrise. Once a dolphin school was located by either vessel, the *CONVEMAR*'s helicopter

would be directed to check the school for presence of yellowfin tuna. If the school was carrying enough tuna to justify making a set for tagging operations (15-tons or greater), preparations would be made aboard the *McARTHUR* to deploy the tagging and tracking personnel and launches. Michael Scott briefed Captain Cervantes about small boat operations near the net during dolphin sets. He stated that it would be desirable for the AR-2 (Boston-whaler with coxswain Wilthof, and Scott, Olson, and Holland) to enter the net immediately following encirclement to start tuna handline fishing operations. Scott intended to transfer to an inflatable raft, delivered by Bratten, shortly after entering the net to direct tagging operations by hand-held radio from inside the net.

The AR-1 (7-meter rigid-hulled inflatable), containing a coxswain (Swanson), the NOAA dive team (Herring, Beaverson, and Harper) and Armstrong and Galdana was to be launched second and to move to a position outside the first bow bunch. Upon arrival at the net, Armstrong was instructed to enter the net equipped with mask, snorkel, and fins to assist Bratten with the assessment of conditions inside the net. The NOAA dive team was to enter the net when the half-net marker had been rolled aboard. The AR-4 (9-meter primary tuna tracking launch) would be deployed third with a coxswain (Cochran) and the dolphin-tagging team (Chivers, Rhinehart, Niemer, and Daniels) aboard. The AR-4 would deploy the dolphin-tagging team's rafts and personnel near the corkline of the backdown channel. The helmsman would hold the launch in position to pick up Holland at the conclusion of handline fishing operations so he could direct the tuna tracking operations. The AR-3 (9-meter secondary tuna tracking launch) containing helmsman (Hermanson) and NOAA executive officer Moen was to be launched last. The AR-3 would maintain its position outside the backdown channel to facilitate pick up of Olson when handline fishing operations ceased so he could conduct tuna-tracking operations.

Dolphin capture and subsequent tagging procedures were planned to begin when the net had been rolled to the tie-down point and handline fishing ceased. Scott would inform dolphin capture personnel when to grab a dolphin. The dolphin tagging personnel would identify the color pattern, measure, and check the sex of the dolphin when it was delivered to the tagging raft. Once a dolphin was lifted into the raft, Daniels was responsible for recording a tally of the dolphins respirations during the tagging procedure. The attachment of tags would be done inside a partially flooded raft by Chivers and Rhinehart. The dolphin were to be outfitted with a radio-transmitter mounted on a fiberglass saddle which would be attached to the dorsal fin by two 1/4-inch delrin pins and magnesium nuts. After tagging operations were completed the dolphin would be released back inside the net.

Following the release of the animals, tracking of dolphins and tuna would begin. The *McARTHUR*, the AR-4, and AR-3 would be the primary tracking platforms. When practical, the *McARTHUR* was to follow the dolphins and the AR-4 and AR-3 would follow the tagged yellowfin tuna. If the tagged tuna and tagged dolphin became separated by more than 8-10 miles, Armstrong and García would transfer from the *McARTHUR* to the *CONVEMAR* to assist Bratten with dolphin tracking.

Commander Peterson stated his vessel's limited ability to safely deploy and recover the tracking launches in Beaufort Sea State greater than 3 and during short-period swells. The captains of both vessels determined safe operating distances during the chase and encirclement phases of the set. The cut-off time for tagging operations was designated to be 15:00 hr. On days when a set was not made by the cut-off time, Captain Cervantes was free to make sets with permission from Scott. The two vessels were advised to maintain a distance of 8-12 miles from each other during search to maximize search area and minimize the *McARTHUR's* travel time to the *CONVEMAR* when it makes a set. Scott informed Captain Cervantes that he would prefer to fish farther than 50 miles from the shore to avoid capturing coastal spotted dolphins.

The *CONVEMAR's* personnel returned to their ship and commenced marine mammal search at 11:00 hr. The *CONVEMAR* started chasing a spotted dolphin school at 15:26 hr. This chase led to Set No. 2. The set was made too late in the day to tag animals (after cut-off time). The AR-2 was deployed with the dive team, two NOAA personnel who would be driving launches, and myself. I was instructed by Scott, to familiarize the group with various sectors of the net, and take them inside the purse-seine with snorkeling gear to observe tuna and dolphin behavior inside the net during backdown. I noted that the porpoise safety panel was not marked with buoys. I asked Bratten to request attachment of an orange float to the corkline at the apex of the backdown channel. A buoy would create a useful reference point for tracking launch drivers. A small canopy formed on the bow side of the apex of the porpoise safety panel during backdown. Personnel involved with dolphin release were instructed to check this area during backdown to prevent dolphin mortalities. The AR-2 transported equipment to the purse-seine vessel after the set was completed. The vessel spent the evening in transit to 18°N and 104°W. Search effort was scheduled to resume around 06:00 hr.

11 November 1993

(Noon Position: 18°16'N and 104°42'W)

Daily Activities:

The *McARTHUR's* position was 18°41'N and 105°11'W at 06:00 hr. Scott was transported to the *CONVEMAR* by speedboat at 06:30 hr to set up and test dolphin radio-tracking gear. Marine mammal sighting effort began at 07:00 hr.

There were a couple of interesting sightings recorded by the *McARTHUR's* scientific field party during the morning. A school of 30-40 Risso's dolphins were located "logging" at the surface at 08:45 hr. The school was loosely aggregated into several subgroups of five to ten individuals (Sighting No. 1: *Grampus griseus* 18°35'N and 105°02'W). A group of several rough-toothed dolphins came near the vessel at 10:35 hr and rode the bow wave. I collected a biopsy sample from an animal that was riding the bow wave (sample #30) (Sighting No.2: *Steno bredanensis* 18°24'N and 104°50'W). A single goose-beak whale was sighted slow-rolling near the vessel at 12:00 hr. It lifted its head out of the water prior to making a final deep dive (Sighting No. 3: *Ziphius cavirostris* 18°16'N and 104°42'W).

In the afternoon the deck crew deployed PNAAPD'S "DOLPHIN-SAFE" jet-boat and it was towed by speedboat to the *CONVEMAR*. I took several photos of the *CONVEMAR* today. We sent our EMT to the seiner to provide first aid to a crewman with a deep cut on his shin. Search effort ended at 14:30 hr. The vessels travelled southwest all night.

12 November 1993

(Noon Position 15°20'N and 105°35'W)

Daily Activities:

The *McARTHUR*'s position was 16°00'N and 106°01'W at 06:00 hr. Marine mammal search started at 06:25 hr. The helicopter checked a school of dolphins sighted from the *McARTHUR* at 08:45 hr (Sighting No. 4: "Spotters" 15°44'N and 105°53'W). They reported 80 "spotters" that were carrying five tons of yellowfin tuna. We were able to see the seabird flock (30-40 brown and red-footed boobies), but not the dolphins from the ship. The fish spotter reported that there was not enough yellowfin tuna associated with the dolphins to justify making a set.

A school of an estimated 500 dolphins ("spotters") was reported from the helicopter at 10:30 hr (Sighting No.5: "Spotters" 15°28'N and 105°46'W). The school was associated with a bird flock. The dolphins were reported to be fairly scattered. The *McARTHUR* was approximately 18 miles from the *CONVEMAR* when the school was sighted so we headed toward the helicopter's position at full speed. By the time we had closed within two or three miles, the school had spread farther apart and had become unworkable. The school was not observed from the *McARTHUR*. During the remainder of the afternoon the *CONVEMAR* located a few more bird flocks and dolphin schools but none of them were carrying enough yellowfin tuna to justify a set. Marine mammal search ended at 15:30 hr. The vessels stopped for the night at 19:00 hr. A dipnet station was conducted from 21:00-23:00 hrs to collect additional bait to fish for tuna by handline.

13 November 1993

(Noon Position: 14°08'N and 104°22'W)

Daily Activities:

Marine mammal search began at 06:30 hr and the position was 14°38'N and 105°03'W. A seabird flock was sighted at 07:10 hr from the *McARTHUR* that contained 20-25 brown and red-footed boobies, and at least one frigate bird. The helicopter was directed to the school and the fish spotter reported seeing 60-70 spotted dolphins but no tuna (Sighting No.6: *Stenella attenuata* [northeastern offshore stock] 14°36'N and 104°57'W).

A flock of 20-30 brown and red-footed boobies was sighted at 10:00 hr from the *McARTHUR*. There was a small, scattered, mixed school of spotted and bottlenose dolphins travelling under the birds. We observed a few tuna jumping under the birds from the ship. There was not enough tuna associated with the school to justify making a set, so the ship ran through the school to get a better look at the species composition of the herd (Sighting No. 7: *Stenella attenuata* [northeastern offshore stock], *Tursiops truncatus*: 14°15'N and 104°38'W). The helicopter reported a large school of "spotters" (700-800) at

10:19 hr (Sighting No. 8: "*Spotters*" 14°13'N and 104°35'W). This school was not observed by personnel aboard the *McARTHUR*. The dolphin school was reported to be separated into at least three groups. The *CONVEMAR* deployed its speedboats and chased the school for several minutes. The school exploded into several subgroups and most of the dolphins evaded the chase. Captain Cervantes reported seeing approximately three tons of yellowfin tuna associated with the dolphins which was not enough to justify making a set for tagging and tracking operations.

The fish spotter in the helicopter checked a school of dolphins associated with birds at 12:45 hr. He reported seeing approximately 200 "spotters" (Sighting No. 9: "*Spotters*" 13°59'N and 104°13'W). The speedboats were deployed to make the dolphins run. Tuna are more visible from the air when dolphins are running and the fish spotter wanted to check if there were more tuna present than he had originally estimated. After making the dolphins run, the fish spotter reported there was insufficient tuna associated with the dolphins to justify making a set for tagging and tracking. This school was not observed by personnel aboard the *McARTHUR*.

A large flock of birds was sighted from the *McARTHUR* at 14:05 hr. It was composed of an estimated 70-100 brown and red-footed boobies, two to three frigate birds, and several Leach's storm petrels. The helicopter was sent to check the school and the fish spotter estimated that there were 100 dolphins in the school (Sighting No. 10: 30% *Stenella attenuata* [northeastern offshore stock] and 70% *Stenella longirostris orientalis* 13°50'N and 104°01'W), but insufficient tuna to justify making a set. The dolphins were visible from the *McARTHUR* and we observed making high leaps, porpoising, and exhibiting spinning behavior. Search effort aboard the *McARTHUR* ended at 15:30 hr. The helicopter was sent to check two schools of dolphins sighted from the *CONVEMAR* at 15:53 hr. The first group of "spotters" was not carrying tuna. The second group of "spotters" was chased by speedboats for several minutes but was not carrying enough tuna to rationalize making a set. After the chase was completed the vessels held station until morning.

14 November 1993

(Noon Position: 13°19'N and 102°37'W)

Daily Activities:

The vessel's search effort started at 06:20 hr. The starting position for the day was 13°33'N and 103°25'W. A fairly large flock of birds was sighted beyond the horizon from the *McARTHUR* at 07:20 hr. By the time the vessels reached the dolphins the bird flock had dispersed (Sighting No. 11: *Unidentified dolphins* 13°34'N and 103°15'W). The vessel turned away from the school and approximately 60-70 unidentified dolphins were observed running low (finning) away from the ship.

A small group of eastern spinners were observed finning approximately 1/10 of a mile off the starboard bow of the *McARTHUR* at 09:23 hr (Sighting No. 12: *Stenella longirostris orientalis* 13°30'N and 102°50'W). None of the dolphins approached the vessel but the

school continued to travel parallel to but in the opposite direction to that of the ship. No birds were observed associated with the dolphins.

The helicopter reported several small, scattered, mixed schools of "spotters and spinners" at 10:00 hr (Sighting No. 13: "*Spotters and Spinners*" 13°24'N and 102°46'W). These schools were not observed by personnel aboard the *McARTHUR*. A large flock of approximately 50-70 brown and red-footed boobies, frigate birds, and Leach's storm petrels was sighted by personnel aboard the *McARTHUR*. The helicopter was sent to check for presence of dolphins. At 11:20 hr the fish spotter in the helicopter reported seeing approximately 500 "spotters and spinners" but he did not report seeing any tuna associated with the school (Sighting No. 14: *Stenella attenuata* [northeastern offshore stock] *Stenella longirostris orientalis* 13°20'N and 102°33'W).

A flock of birds associated with dolphins was located from the *CONVEMAR* at 14:52 hr (Sighting No. 15: "*Spotters*" 13°26'N and 102°09'W). The helicopter checked the school and reported no tuna were observed. The school was not observed by personnel aboard the *McARTHUR*. Search was concluded at 15:30 hr.

15 November 1993

(Noon Position: 13°30'N and 101°06'W)

Daily Activities:

Marine mammal search commenced at 06:06 hr and the starting position was 13°26'N and 101°49'W. A small school of (95%) spotted and (5%) spinner dolphins was sighted under 20-30 red-footed, masked, and brown boobies at 07:19 hr (Sighting No. 16: *Stenella attenuata* [northeastern offshore stock], *Stenella longirostris orientalis* 13°25'N and 101°35'W). The school was loosely aggregated into one widely scattered group. No tuna were reported associated with the dolphins. The helicopter was deployed to check a flock of birds sighted from the *CONVEMAR* at 08:00 hr. Observers on the *McARTHUR* reported seeing 50-60 red-footed, and brown boobies with the high powered glasses. The fish spotter aboard the helicopter reported 50 "porpoise" and no tuna (Sighting No. 17: "*Porpoise*" 13°27'N and 101°30'W). A mixed school of spotter, spinner and a couple of bottlenose dolphins was located by fish spotters of the *CONVEMAR* at 10:18 hr. The helicopter was deployed and the fish spotter reported seeing approximately 200 dolphins traveling under a seabird flock and six to eight tons of tuna associated with the school (Sighting No. 18: *Stenella attenuata* [northeastern offshore stock], *Stenella longirostris orientalis*, *Tursiops truncatus* 13°31'N and 101°10'W). The chief scientist gave captain Cervantes permission to make a set.

The *McARTHUR* was four to six miles from the *CONVEMAR* when the net was deployed for Set No. 3. We arrived in position to deploy the auxiliary vessels after the "rings up" stage of the purse-seine net retrieval process. Each of the four auxiliary launches were deployed from the *McARTHUR*. A steering failure occurred on the AR-4 immediately following its deployment. The AR-4 was the primary tuna tracking launch so this was a critical breakdown. The AR-1 arrived at its position outside the bow bunch after the 1/2-

net marker had been rolled aboard which was later in the set sequence than normal. The tagging operation was called off by Scott because of several logistical problems related to late arrival of the tagging and tracking team at the net. A list of the problems follows.

- ▶ The AR-4 had a steering malfunction that delayed its arrival at the net.
- ▶ There was not enough time for the NOAA divers to attempt to tag fish because the AR-1 did not arrive at the net until after the 1/2-net marker had been rolled aboard and the divers did not enter the water until shortly before the net was tied down for the backdown.
- ▶ The set was made when the *McARTHUR* was too far away from the *CONVEMAR* to deploy equipment and personnel early enough in the set to tag and track dolphins and tuna.

The set was a good practice session for everyone involved with tagging and tracking operations on both ships. The set pointed out some of the little things that can go wrong during a full-scale operation and allowed the scientific field party and ship's personnel to address them prior to a more promising opportunity to tag and track dolphins and tuna. The *CONVEMAR* loaded four to five tons of yellowfin tuna. There were no dolphin mortalities.

A small school of approximately 25-30 eastern spinner dolphins (Sighting No. 19: *Stenella longirostris orientalis* 13°35'N and 101°08'W) was sighted approximately a 1/2 mile ahead of the *McARTHUR* at 14:04 hr. The school was chased by the *McARTHUR* to obtain positive species and stock identification. A portion of the school came near the ship and rode the bow and quarter waves. Crewmen aboard the *CONVEMAR* located a flock of seabirds and sent the helicopter to check them for dolphins and tuna at 14:41 hr. The fish spotter reported seeing 250 dolphins (Sighting No 20: "*Spotters*" 13°36'N and 101°03'W). It was too late in the day to make a set and conduct full scale tagging and tracking and the fish spotter did not see enough tuna to support making a set for commercial purposes.

A school of an estimated 250 spotted dolphins was sighted from the *McARTHUR* at 15:40 hr (Sighting No. 21: *Stenella attenuata* [northeastern offshore] 13°31'N and 100°53'W). There were no seabirds associated with the school. The *McARTHUR* chased the school and some of the dolphins came to the bow and rode the bow and quarter waves. Mammal search aboard the *McARTHUR* ended at 16:00 hr. Scott, Holland, Olson traveled to the *CONVEMAR* to meet with Captain Cervantes to discuss the set and inquire about the possibility of slowing down specific events during the set sequence (such as net roll) to provide more time to tag tuna and dolphins inside the net.

16 November 1993
(Noon Position: 14°12'N and 100°50'W)

Daily Activities:

Marine mammal search started at 06:07 hr and the starting position was 13°24'N and 100°50'W. Commander Peterson reported that increased wind and short-period swells would inhibit launch deployment and recovery operations from the *McARTHUR*. A small school of spotted dolphins was located by scientists aboard the *McARTHUR* at 06:45 hr (Sighting No. 22: *Stenella attenuata* [northeastern offshore] 13°24'N and 100°42'W). The school was running low (finning) under five to ten red-footed and brown boobies. The school size was estimated by personnel aboard the *McARTHUR* to be approximately 15-25 dolphins and no tuna.

The *CONVEMAR*'s fish spotter reported a mixed school of "spotters and spinners" under a flock of seabirds (Sighting No. 23: *Stenella attenuata* [northeastern offshore], *Stenella longirostris orientalis* 13°23'N and 100°42'W). The school size was estimated from the *CONVEMAR* by Bratten to be 60-70 dolphins. The *CONVEMAR* ran through the school and some of the dolphins came over and rode the bow wave.

The Beaufort sea state degraded to the point (> Beaufort 5) that search effort aboard the *McARTHUR* was ended at 09:00 hr. A large green sea turtle, *Chelonia mydas* was sighted basking at the surface with a mature masked booby standing on its carapace at 10:38 hr. The position of the turtle sighting was 14°01'N and 100°37'W. An improvement in sea surface conditions permitted marine mammal search to resume at 11:10 hr. Personnel aboard the *CONVEMAR* located a flock of seabirds that was plunge-diving near a dolphin school at 11:23 hr (Sighting No. 24: *Stenella attenuata* [northeastern offshore], *Stenella longirostris orientalis* 14°12'N and 100°50'W). The helicopter was dispatched. The fish spotter in the helicopter observed a mixed school of approximately 500 "spotters and spinners." The dolphins were carrying a few tons of fish and the speedboats were deployed to chase the school. Commander Peterson determined that sea surface conditions were not suitable for launch and recovery of the tracking launches (Beaufort 3, 3-4 foot short-period swells). Scott indicated that he was going to send the dive team inside the net to practice tagging tuna if the *CONVEMAR* made a set. Captain Cervantes chose not to set on the school.

At 13:25 hr search was resumed by both vessels. The fish spotter in the helicopter checked a flock of seabirds sighted from the tuna vessel and reported seeing 12 "porpoise" but no fish (Sighting No. 25: "Porpoise" 14°21'N and 101°01'W). The dolphins were not observed by personnel aboard the *McARTHUR*.

The fish spotter in the helicopter reported a school of approximately 50 copulating "spotters" several miles ahead of the *McARTHUR* at 14:35 hr (Sighting No. 26: *Stenella attenuata* [northeastern offshore] 14°25'N and 101°03'W). We continued travelling toward the school and observed spotted dolphins finning under approximately 25-30 red-footed, brown, and masked boobies. The fish spotter in the helicopter inspected a flock of

birds first sighted from the tuna boat at 14:49 hr. He reported seeing seven dolphins but no fish (Sighting No. 27: "Spotters" 14°27'N and 101°06'W).

A large flock of seabirds was sighted from the *McARTHUR* at 15:10 hr. The helicopter was sent to check the birds and the fish spotter reported observing 700-800 scattered spotted dolphins but no tuna (Sighting No. 28: *Stenella attenuata* [northeastern offshore] 14°31'N and 101°08'W). At 15:56 hr we passed through the school. The dolphins were travelling in many loosely aggregated subgroups. Several dolphins came to the bow and rode the bow, quarter, and stern waves. A pair of 15-20 lb yellowfin tuna were caught on hand-lines when we passed through the school. Search effort ended at 16:00 hr on both ships.

17 November 1993
(Noon Position: 15°01'N and 103°00'W)

Daily Activities:

Marine mammal search started at 06:34 hr and the position was 15°56'N and 103°48'W. A flock 20 seabirds (Sulids) was sighted over a school of approximately 100 spotted dolphins at 06:58 hr (Sighting No. 30: *Stenella attenuata* [northeastern offshore] 15°56'N and 103°45'W). The helicopter checked the school and reported no fish associated with the dolphins.

The helicopter was flying toward a flock of seabirds sighted from the *McARTHUR* at 10:15 hr. The fish spotter in the helicopter reported seeing a school of 55 "spotters and spinners" (40 spotters and 15 spinners) (Sighting No 31: *Grampus griseus* and *Unidentified* dolphins 15°59'N and 103°10'W). There were no birds or fish reported. When the *McARTHUR* passed through the school, the cetacean identification specialist noted that some of the dolphins were Risso's dolphins while some were not identifiable with certainty, but were most likely rough-toothed dolphins.

A seabird flock made up of approximately two frigate birds, 50-60 red-footed, brown, and masked boobies was sighted from the *McARTHUR* at 10:20 hr and inspected by the fish spotter in the helicopter. He reported a mixed school of 400 "spotters (90%) and spinners (10%)" (Sighting No.32: *Stenella attenuata* [northeastern offshore], *Stenella longirostris orientalis* 15°59'N and 103°10'W). There were no yellowfin tuna observed associated with the dolphins. We drove through the school to collect a biopsy sample, but only two spotted dolphins came to the bow (a fused and a mottled individual). They rode very deep on the bow wave for a minute or so and veered off toward the stern. No shots were taken with the cross bow. Scott took several photographs of the dolphins (Roll # MDS-1, FRAMES 1-10).

The fish spotter in the helicopter checked a school of dolphins sighted from the *CONVEMAR* at 12:00 hr and reported seeing 60 "spotters" but no tuna (Sighting No. 33: "Spotters" 15°01'N and 103°00'W). This school was not observed by personnel aboard the *McARTHUR*. A seabird flock made up of approximately 30-40 red-footed and brown

boobies, and at least one frigate bird, was sighted by personnel aboard the *McARTHUR* at 13:35 hr. The helicopter was sent to check the seabirds for associated dolphins and tuna. The fish spotter in the helicopter reported scattered groups of dolphins chasing "bait" near the birds (Sighting No. 34: *Stenella attenuata* [northeastern offshore], *Stenella longirostris orientalis* 16°08'N and 102°44'W). We observed a mixed school of spotted and spinner dolphins from the *McARTHUR*. It was widely scattered into several subgroups. The dolphins were observed making random movements as if feeding. Rafts of flying fish were sighted in areas where dolphin surface activity was noted.

A group of eastern spinner dolphins was encountered as the *McARTHUR* traveled toward the *CONVEMAR* (Sighting No. 35: *Stenella longirostris orientalis* 16°04'N and 102°37'W). It was probably a subgroup of the school described in Sighting No. 34. The dolphins were tightly bunched into one group. The *McARTHUR* drove through the school several times so scientific field party members could take photos and I could attempt to collect a biopsy sample. Several spinner dolphins rode the bow wave, but I was unsuccessful obtaining a sample (Table 1). I took 3 shots and hit individuals behind the dorsal fin on two occasions but the dart did not collect a sample. Several cow/calf pairs including a neonate were observed swimming near the bow. Search was concluded at 15:15 hr. We travelled past a log and checked it for tuna at 15:19 hr. A small group of two or three rough-toothed dolphins were associated with the log (Sighting No. 36: *Steno bredanensis* 16°04'N and 102°36'W).

18 November 1993

(Noon position: 16°19'N and 102°03'W)

Daily Activities:

Marine mammal search started at 06:12 hr and the ship's position was 16°19'N and 102°03'W. A seabird flock composed of approximately 20 brown and red-footed boobies was sighted from the *McARTHUR* at 08:00 hr. The helicopter was directed to the school and the fish spotter reported seeing approximately 70 "spinners" (Sighting No. 37: *Stenella longirostris orientalis* 16°35'N and 102°20'W). As we approached the school it was apparent that it was widely scattered into several subgroups. When the ship approached within one mile of the school, dolphins started to run (aerial behavior was observed such as porpoising, side-flops, tail-lobs and spinning). Members of the school did not approach the ship.

Scientific field party members on high-power glasses reported small, scattered subgroups of spotted and spinner dolphins and seabirds over a four to five mile radius (Sighting No. 38: *Stenella attenuata* [northeastern offshore], *Stenella longirostris orientalis* 16°48'N and 102°35'W). Seabirds were flying above finning dolphins. Occasionally dolphins made random movements (rushes and splashes) as if they were feeding. The spotted and spinner dolphins were travelling in discrete subgroups.

Whale fluke "foot prints" were sighted ahead of the ship at 10:22 hr. A blue whale was detected with hand-held binoculars as it passed underwater one tenth of a mile in front of

the *McARTHUR* (Sighting No. 39: *Balaenoptera musculus* 16°51'N and 102°39'W). It was heading northwest when originally sighted. The whale surfaced six or seven times before diving for four to six minutes during the its initial two dive profiles. We followed the whale as it made three additional trips to the surface and took photos and recorded video images of its left and right side.

A small, somewhat scattered group of Risso's dolphins was sighted from the *McARTHUR* at 11:32 hr (Sighting No. 40: *Grampus griseus* 16°48'N and 102°46'W). They were observed lying at the surface, slow-rolling, breaching, and spy-hopping. The helicopter fish spotter checked a flock of seabirds sighted from the *CONVEMAR* at 11:32 hr and reported a school of approximately 70-80 "spotters" under the birds but he did not see any tuna (Sighting No. 41: "Spotters" 16°48'N and 102°47'W). The *McARTHUR* turned to check a log, several rough-toothed, and a few bottlenose dolphins that were sighted near flotsam in a drift line (Sighting No. 42: *Steno bredanensis*, *Tursiops truncatus* 16°46'N and 102°49'W). There were three frigate birds and five or six brown boobies associated with the dolphins and the flotsam.

The helicopter was deployed at 13:05 hr to check a flock of seabirds sighted from the *CONVEMAR*. This school of dolphins was not observed by personnel aboard the *McARTHUR*. The fish spotter reported a mixed school of "spotters and spinners (Sighting No 43: "Spotters and Spinners" 16°40'N and 103°02'W." No fish were reported to be associated with the dolphin school. A group of five to seven rough-toothed dolphins was observed at 15:47 hr associated with a log (Sighting No. 44: *Steno bredanensis* 16°48'N and 103°26'W). As the ship approached the log, dolphins exhibited lob-tailing, breaching, and chin-slapping behaviors. Search by the *McARTHUR* was terminated at 16:00 hr. Both vessels drifted all night.

19 November 1993

(Noon Position: 17°49'N and 103°15'W)

Daily Activities:

Marine mammal search began at 06:20 hr and the starting position for the day was 16°58'N and 103°19'W. The helicopter was deployed at 09:14 hr to check a flock of seabirds sighted from the *CONVEMAR*. The fish spotter reported approximately 60-70 "spotters" traveling without tuna under a flock of seabirds (Sighting No.45: "Spotters" 17°30'N and 103°19'W). The school was not observed from the *McARTHUR*.

A small group of rough-toothed dolphins was spotted at 09:32 hr from the *McARTHUR* close to a log (Sighting No. 46: *Steno Bredanensis* 17°36'N and 103°19'W). One brown booby was standing on the log. A tightly associated group of Risso's dolphins was sighted at 10:08 hr from the *McARTHUR* (Sighting No. 47: *Grampus griseus* 17°37'N 103°15'W). The school was composed of 10-15 individuals including a few cow/calf pairs. We approached within 200 meters the school and they dove and reappeared on our starboard side travelling parallel to but in the opposite direction to that of the ship. The dolphins did not approach the ship or ride the bow wave. A flock of 15-25 brown and red-footed

boobies, and two pomarine jaegers were sighted from the *McARTHUR* at 10:10 hr. The helicopter was directed to the flock of seabirds and reported seeing a small school of "spotters" (Sighting No. 48: *Stenella attenuata* [northeastern offshore] 17°37'N and 103°13'W). The dolphin school was widely scattered into several subgroups. Individual dolphins in several subgroups were observed making random movements as if feeding. The ship made a pass through the school to confirm the dolphin stock identification. Small yellowfin tuna were observed feeding at the surface under the birds.

A flock of seabirds was sighted at 13:20 hr from the *CONVEMAR* and checked from the helicopter. The fish spotter reported 150 spotted dolphins with eight to ten tons of associated tuna (Sighting No. 49: *Stenella attenuata* [northeastern offshore] 17°52'N and 103°23'W). Set No. 4 was made on this school. All but 18-20 dolphins evaded or escaped the net during the chase and encirclement phases of the set. An estimated 25 small (10-15 lb) yellowfin tuna were captured. Personnel aboard the *McARTHUR* were alerted to prepare for a full-scale tagging and tracking operation. The set was made around 13:45 hr at position 17°48'N and 103°30'W.

The small boat launch sequence was changed by Scott to AR-2, AR-3, AR-1, and AR-4. The *McARTHUR*'s launches were all deployed within a 1/2 mile of the net. The deployments were accomplished very swiftly and efficiently and all the launches were operational. The AR-2 entered the net just as the stern ortza was brought aboard the *CONVEMAR* and Holland and Olson commenced handline fishing for tuna. The AR-2 arrived at its assigned position outside of the last bow bunch, with the NOAA dive team (Beaverson, Harper, and Herring), Galdano and Armstrong, and Swanson aboard as the purse-rings came out of the water. We geared up for tuna tagging operations and I entered the water with mask, snorkel, and fins and swam to the area inside the net where the dolphins were milling.

Several speckled and at least one two-tone color patterned calves were observed with fused, adult, female spotted dolphins. I counted 18-20 spotted dolphins inside the net. The dolphins were clustered into two or three groups that came to the surface in unison, dived straight down about 10-meters, and then travelled in a horizontal plane as one group. Sometimes during trips to the surface the dolphins came up and took several breaths and then descended, and at other times they would surface to take one breath and headed straight down. The latter behavior was frequently exhibited by cow/calf pairs and they tended to make more trips to the surface than individuals that had taken several breaths before sounding.

I noted jaw-clapping behavior when a fused, male, spotted dolphin got between a cow/calf pair. The cow snapped at the male spotted dolphin and chased him away (video). At the beginning of the set the dolphins seemed to be patrolling the net. They spent most of the time below the surface and tended to come to the surface as a group and descend as a group. Yellowfin tuna were most often very deep in the net and they were generally located under the dolphins.

When the net was rolled to the tie-down point, Bratten and Armstrong were directed by Scott to hand-capture a dolphin and deliver it to the dolphin tagging team. A fused, female spotted dolphin was captured and subsequently released when we discovered she had a calf. We then directed our efforts to hand-capture a fused, male spotted dolphin from a group of dolphins that only had one cow/calf pair associated with it. A 191-cm, fused, male, spotted dolphin (D-7) was captured rather easily and did not struggle very much during its trip to the tagging raft. After D-7 was placed inside the flooded, eight-foot inflatable raft, his length was measured. His respirations were called out and recorded by a member of the tagging team. A radio transmitter tag, integrated with a timed-depth-recorder (TDR) unit transmitting at 148.300 MHz, was attached to the dolphin's dorsal fin. The dolphin was then photographed, a blood sample was taken from a vein on the ventral surface of the flukes, and it was released inside the net to join the rest of the herd. Upon release from the tagging raft, it was surrounded by dolphins and it started moving up and down in the water column with the other dolphins.

It was at this point of the operation that Scott ordered a slow backdown to shape the net and raise the floor of the backdown channel to make the tuna more accessible to the NOAA divers. The divers positioned themselves near the apex of the backdown channel and waited for an opportunity to apply a tag to a tuna. There was never a good opportunity to tag a tuna since there were only about 25 small yellowfin tuna captured during the set. When tuna tagging efforts by divers were judged unfeasible, Scott ordered a hard backdown maneuver, and all of the dolphins and tuna were backed out of the net. The AR-4 tracked D-7 while the AR-1, AR-2, and AR-3 were picked up. The *McARTHUR* acquired a strong transmitter signal at approximately 17:00 hr so the AR-4 was recovered and D-7 was tracked from the *McARTHUR* throughout the night.

20 November 1993

(Noon Position: 17°28'N and 104°08'W)

Daily Activities:

A dolphin school containing D-7 was located at 06:40 hr approximately 20 miles southwest of D-7's release position by the *McARTHUR*. The school was located approximately 3.8 miles in front of the ship. The speedboats were deployed at 08:00 hr after the fish spotter in the helicopter confirmed D-7 was in the school. Scott directed the *CONVEMAR* to conduct a chase. While we were watching the chase, a goose-beaked whale surfaced near the vessel at 08:26 hr (Sighting No. 50: *Ziphius cavirostris* 17°20'N and 103°49'W). The beaked whale was observed slow-rolling a few times before it slipped below the surface.

The skiff was deployed at 08:45 hr for Set No. 5. The set position was 17°21'N and 103°52'W. The fish spotter reported no tuna associated with D-7's school. The purpose of the set was to recover the TDR so the normal standards for making a set based on tonnage of tuna were disregarded. There were 28-34 *Stenella attenuata* (northeastern offshore) and four *Stenella longirostris orientalis* captured in the net. The *McARTHUR* deployed two launches (AR-1 and AR-2) during the set. D-7 was captured by hand and

transported to the dolphin tagging team. The radio-transmitter/TDR package was removed from the dorsal fin by Chivers and Rhinehart and the dolphin was released inside the net. Video footage was taken inside the net during the set. The entire school including D-7 was released during the backdown.

Marine mammal search resumed at 11:00 hr. An unidentified sea turtle (olive ridley/green) was sighted from the *McARTHUR* at 11:28 hr at 17°25'N and 104°01'W. A mixed school of spotted and spinner dolphins was located by the *McARTHUR* at 11:30 hr (Sighting No. 51: *Stenella attenuata* [northeastern offshore] and *Stenella longirostris orientalis* 17°25'N and 104°03'W). The school was travelling low (finning) beneath a flock of 20-30 brown and red-footed boobies. The fish spotter reported seeing 50-70 dolphins (70% "spinners" and 30% "spotters") in the school, but not tuna.

A dolphin school was sighted from the *McARTHUR* at 11:50 hr (Sighting No. 52: *Stenella attenuata* [stock undetermined] and *Stenella longirostris orientalis* 17°26'N and 104°05'W). The dolphins were running low under a flock of five brown boobies. The helicopter overflying the school did not see any tuna. A school of approximately 50 "spotters" was located from the helicopter at 12:57 (Sighting No. 53: "Spotters" 17°37'N and 104°05'W). The fish spotter reported one-half a ton of tuna with the school. The school was not observed from the *McARTHUR*.

Several scattered flocks of seabirds and dolphins were located from the *McARTHUR* (Sighting No. 54: *Stenella attenuata* [northeastern offshore], *Stenella longirostris orientalis*, and *Tursiops truncatus* 17°49'N and 104°00'W). The school was separated into several large subgroups widely scattered over four to five miles. The spotter in the helicopter reported an estimated 1000 "spotters and spinners" in the school. Some of the subgroups were reported to be carrying yellowfin tuna. The *CONVEMAR* made a set on one of the subgroups that was carrying fish.

Set No. 6 was made at 16:00 hr at 17°05'N and 103°55'W, on approximately 40 spotted dolphins. The set occurred late in the day after the designated cut-off time for full scale tagging and tracking of tuna and dolphins. The AR-1 was deployed and I video taped a PNAAPD *Bubble-Curtain* experiment. During the deployment of the bubble-curtain gear, the hose ended up bisecting the apex of the backdown channel. The position of the hose was not optimal for pushing dolphins toward the apex of the backdown channel or preventing movements toward the *CONVEMAR*. When the air supply that creates the bubbles was turned on, dolphins which were rafting at the apex of the backdown channel remained stationed on one side of the curtain. Some of the dolphins reacted to the bubbles by making erratic movements away from the bubble curtain and the jet-boat engine wash. Several dolphins were observed crashing into the Porpoise Safety Panel (PSP) during their attempts to move away from the curtain. Swimmers requested that the bubbles be turned off so that dolphins could be released safely from the net during backdown. Dolphin rescue and release operations were completed inside the purse-seine net at 17:00 hr.

21 November 1993

(Noon Position: 18°35'N and 104°00'W)

Daily Activities:

Marine mammal search aboard the *McARTHUR* began at 06:37 hr, at 18°13'N and 103°54'W, and a school of spotted dolphins was sighted almost immediately by personnel aboard the *McARTHUR* (Sighting No. 55: *Stenella attenuata* [northeastern offshore] 18°13'N and 103°54'W). This school was observed slow-rolling off the ship's port beam. A few brown boobies flew over the school, made a few circles, and continued on their way.

A school of spotted dolphins was sighted from the *McARTHUR* at 06:42 hr (Sighting No. 56: *Stenella attenuata* [northeastern offshore] 18°15'N and 103°54'W). Approximately 50-100 spotted dolphins were observed running low in a cohesive school. There were no seabirds associated with the school. A school of approximately 30-50 common dolphins was observed at 07:11 hr. The dolphins were slow-rolling under a flock of 20-30 brown and red-footed boobies (Sighting No. 57: *Delphinus delphis* [short-beak] 18°19'N and 103°55'W). The *McARTHUR* approached the school to obtain a species stock identification. A few members of the school came to the ship and rode very deeply on the bow wave, then veered off to the stern to rejoin the rest of the school. Approximately three to five slow-rolling rough-toothed dolphins were sighted from the *McARTHUR* at 07:50 hr (Sighting No. 58: *Steno bredanensis* 18°21'N and 103°59'W). The dolphins were not associated with flotsam.

The fish spotter in the helicopter located a school of approximately 400 "spotters" travelling under a flock of seabirds at 08:00 hr (Sighting No. 59: *Stenella attenuata* [northeastern offshore] 18°22'N and 103°59'W). Set No. 7 was made on this school. The *CONVEMAR* captured 60-70 spotted dolphins. A small school of three rough-toothed dolphins was observed from the *McARTHUR* (Sighting No. 60: *Steno bredanensis* 18°23'N and 103°59'W) at 08:03 hr. An unidentified beaked whale was also sighted from the *McARTHUR* as we prepared for tuna and dolphin tagging at 08:30 hr (Sighting No. 61: *Unidentified Ziphid sp.*, 18°30'N and 104°00'W).

The *CONVEMAR* made Set No. 7 at 08:45 hr, at 18°34'W and 103°58'W. Full-scale tagging and tracking of tuna and dolphins was carried out during this set. Underwater video footage was taken inside the net. A fused, 198-cm, female, spotted dolphin (D-8) was captured and delivered to the dolphin tagging team. A radio-transmitter/TDR package broadcasting at 148.370 MHz was attached to the dorsal fin of D-8 and it was released inside the net. Two 60-lb yellowfin tuna (T-1 and T-2) were tagged by lance with sonic-transmitters. T-1 was tagged with a model V7P: 50 KHz depth sensitive transmitter with an effective transmitting range of 0.75 - 1.0 nm, and T-2 was tagged with a V3: 60 KHz sonic pinger with an effective transmitting range of 0.5 - 0.75 nm. T-2's tag only provided tracking personnel with horizontal movement data. The tags were applied by the lance-tagging method by Armstrong and Bratten who were free-swimming inside the net with mask, snorkel, and fins during the backdown. T-1 was released from the net during

backdown and followed by the tuna tracking team for 31 hours. The tag was attached to T-1 slightly posterior to the right side of the dorsal fin. T-1 and D-8 were tracked all afternoon from the AR-4, AR-3, and the *McARTHUR*.

A loosely aggregated school of approximately 400-500 spotted dolphins was located from the *McARTHUR* at 15:00 hr (Sighting No. 62: *Stenella attenuata* [stock undetermined] 18°36'N and 104°07'W). The school was initially sighted travelling under 20-30 plunge-feeding brown boobies. As the ship approached the school, several dolphins came up and rode the bow wave. Some of them were very long (> 210 cm), but not as robust-bodied as coastal spotters that I have observed off of Panama. There were a few heavily spotted individuals in the school, but the majority of the fused individuals were moderately spotted. My best guess was that the dolphins were northeastern offshore stock. I collected two biopsy samples (samples #31-32, APPENDIX 2) from bow-riding dolphins for analysis by the SWFSC genetics lab.

Several small, scattered, groups of spotted dolphins, were observed by the scientists aboard the *McARTHUR*, travelling under seabird flocks (Sighting No. 63: *Stenella attenuata* [northeastern offshore] 18°36'N and 104°08'W). The dolphins were widely scattered into several subgroups. Some of the dolphins were observed making random movements as if feeding.

A pair of Humpback whales were sighted from the *McARTHUR* at 15:38 hr (Sighting No. 64: *Megaptera novaeangliae* 18°37'N and 104°08'W). They were observed slow-rolling three to five times and raising their flukes before sounding for 1.5 - 2.0 minutes. Because we were tracking dolphins and tuna we could not approach the whales to obtain photos. Marco García and I were transferred to the *CONVEMAR* to assist Bratten with dolphin tracking aboard the seiner throughout the night.

22 November 1993

(Noon Position: 18°49'N and 104°20'W)

Daily Activities:

While I was aboard the *CONVEMAR* assisting with dolphin tracking efforts, scientific field party members conducted search effort aboard the *McARTHUR*. I recorded the sighting numbers and positions from the Ship's Marine Operations Abstract upon my return, but I did not receive species identifications and field notes. The sighting data were delivered directly to Scott. The sighting times, numbers, and positions are listed below.

- ▶ 09:50 hr Sighting No. 65: 18°50'N and 104°21'W.
- ▶ 10:03 hr Sighting No. 66: 18°51'N and 104°21'W.
- ▶ 10:07 hr Sighting No. 67: 18°51'N and 104°21'W.
- ▶ 10:26 hr Sighting No. 68: 18°49'N and 104°19'W.

Dolphin tracking effort aboard the *CONVEMAR* ended at 22:00 hr and Armstrong and García were returned by speedboat to the *McARTHUR*. Tracking efforts by the

McARTHUR's scientific field party continued throughout the night.

23 November 1993

(Noon Position: 18°38'N and 104°04'W)

Daily Activities:

Scientific field party members started searching with the 25X glasses for D-8 at 06:00 hr beginning at 18°41'N and 104°02'W. I was sleeping until just after the net skiff was deployed for Set No. 8 so I did not get an estimate of school size prior to the set.

The *CONVEMAR* made Set No. 8 at 08:47 hr at 18°37'N and 104°02'W. D-8 was captured in the set along with 200 spotted dolphins, *Stenella attenuata* [northeastern offshore] and one short-beaked common dolphin, *Delphinus delphis* [short-beak]. The stern end of the purse-line cable parted when the vessel was pulling in the tow-line. A net roll-up occurred on the bow side of the purse-cable rings subsequent to the parting of the purse-cable.

The dolphin-tag-recovery personnel were placed in stand-by mode while captain Cervantes directed the deck crew to recover the purse-cable by winching it through the rings and rolling it onto the bow-side purse-cable drum. Once the cable had been brought aboard, the crew worked on the bow side roll-up and cleared it so the net retrieval process could begin. As soon as the captain had control of the net, chain line, and rings, he signaled it was safe for scientific personnel to enter the net. The net was rolled to the tie-down marker and the Armstrong and Bratten hand-captured D-8 and delivered her to the tag-recovery team. The radio-transmitter/TDR package was removed from the dorsal fin (data had been recorded on the TDR for 49 hours) and D-8 was released inside the net. No underwater video footage was taken during the set. At backdown there was a small net collapse that was caused because there were approximately five fathoms too much corkline in the water. A fused, pregnant, female and a two-toned, male spotted dolphin died during the set. The dead dolphins were retrieved from the *CONVEMAR* and a complete postmortem dissection was performed by Scott, Chivers, and Rhinehart aboard the *McARTHUR* (Photos were taken by Armstrong). Approximately 15 tons of yellowfin tuna were brailled aboard the ship. We drifted for the remainder of the day while the *CONVEMAR* repaired its purse-cable and net.

24 November 1993

(Noon Position: 18°55'N and 105°06'W)

Daily Activities:

Marine mammal search began at 06:15 hr at 18°28'N and 105°06'W. A few scattered groups of finning Risso's dolphin were sighted from the *McARTHUR* at 07:58 hr (Sighting No. 69: *Grampus griseus* 18°40'N and 104°40'W). The groups were finning parallel to but in the opposite direction to that of the ship. Aerial behaviors such as side-flops, porpoising, and lob-tailing were observed when the *McARTHUR* passed within 100 meters of the school. Several small, scattered, groups of spotted dolphins were observed from the *McARTHUR* at 08:43 hr (Sighting No. 70: *Stenella attenuata* [northeastern offshore])

18°47'N and 104°47'W). The vessel made a pass through this scattered school travelling under 70-100 brown boobies, and unidentified shearwaters. Small yellowfin tuna were feeding at the surface near some of the subgroups of dolphins and the plunge-feeding brown boobies. Two dolphins rode the bow wave briefly then veered off and rejoined the school. A small long-line or gill-net fishing vessel, setting its gear, was seen from the *McARTHUR* at 09:32. A small group of rough-toothed dolphins was observed close to the ponga and the fishing gear (Sighting No. 71: *Steno bredanensis* 18°51'N and 104°48'W).

The *McARTHUR*'s search was suspended at 09:52 hr so the tuna-tagging team could launch AR-4 to test some tracking gear. The launch was recovered at around 11:00 hr and search was resumed at 12:00 hr. A small group of three to five bottlenose dolphins was observed finning toward the *McARTHUR* at 12:26 hr (Sighting No. 72: *Tursiops truncatus* 18°55'N and 105°11'W). The dolphins were observed finning toward the bow of the *McARTHUR* as if they were going to ride the bow wave. They veered away 100 meters from the ship and travelled along her port side. The sea surface conditions became too rough to deploy the tracking launches at 11:30 hr so we drifted the remainder of the day.

25 November 1993

(Noon Position: 18°39'N and 105°48'W)

Daily Activities:

Marine mammal search commenced at 06:30 hr and the starting position was 18°53'N and 105°28'W. A flock of 20-30 brown boobies and two frigate birds was sighted at 06:38 hr from the *McARTHUR*. Dolphin-sized splashes were seen under the birds (Sighting No. 73: *Stenella attenuata* [northeastern offshore] 18°53'N and 105°28'W) and led to helicopter deployment to check the dolphin school for associated tuna. The helicopter reported 150 spotted dolphins carrying some scattered tuna. The speedboats were deployed, the school was chased, and Set No. 9 was made.

Set No. 9 began at 07:50 hr at 18°53'N and 105°32'W. Most of the dolphins in the school, except for 20 spotted dolphins (predominantly cow/calf pairs), evaded the set. Underwater video footage was recorded during the set. The water was very murky and visibility was limited. Bratten and Armstrong searched for yellowfin tuna inside the net with skin diving gear. Tuna were located inside the net prior to the 1/2-net buoy being rolled aboard. An estimated one ton of mostly small tuna was observed by swimmers inside the net. A bubble-curtain experiment was performed by PNAAPD personnel during the set. The bubble hose was stretched across the backdown channel and the jet-boat was moved inside the net. When the operator attempted to maneuver the jet-boat outside of the corkline he inadvertently created a large area of bubbles. The dolphins moved to the apex of the backdown channel in response to the combination of the bubble-curtain and the jet-wash. The bubble-curtain was turned off after a few moments and the vessel conducted a normal backdown maneuver. All dolphins were released alive. One ton of yellowfin tuna 15-20 lb, with some about 60-80 lb, were rolled aboard in the bow ortza webbing.

The fish spotter in the helicopter reported a school of 30-40 spotted dolphins at 11:06 hr

(Sighting No. 74: "Spotters" 18°45'N and 105°35'N). The school of spotters was travelling under a seabird flock which was sighted from the *CONVEMAR*. There were no tuna. This school was not observed from the *McARTHUR*.

The fish spotter in the helicopter reported 300-400 "spinners" at 11:18 hr (Sighting No. 75: "Spinners" 18°43'N and 105°35'W). The dolphins were not associated with seabirds and were not carrying tuna. The dolphins were not discernable from the *McARTHUR*. Three large flocks of birds were sighted from the crow's nest of the *CONVEMAR* at 12:13 hr. The largest flock contained 150-200 seabirds. The other flocks were composed of 30-50 seabirds. The helicopter checked the seabird flocks and reported scattered dolphins under the birds but no tuna were associated with the dolphins (Sighting No. 76: *Stenella sp.*, 18°38'N and 105°28'W).

The *CONVEMAR* reported that it passed through a mixed school of 12-15 bottlenose and 10 Risso's dolphins (Sighting No. 77: *Tursiops truncatus*, and *Grampus griseus* 18°36'N and 105°27'W). This school was not seen from the *McARTHUR*. A large flock of three or four frigate birds and 200-300 brown and red-footed boobies was sighted six to eight miles ahead of the *McARTHUR* at 13:46 hr. Dolphins were associated with the bird flock (Sighting No. 78: *Stenella attenuata* [northeastern offshore], and *Stenella longirostris orientalis* 18°21'N and 105°21'W). The helicopter reported scattered dolphins, but not much fish. We made several passes through a few of the dispersed subgroups of dolphins with the *McARTHUR* to take photos and collect biopsy samples (samples #33 and #34 APPENDIX 2). The fish spotter discovered a subgroup of dolphins that was carrying tuna and the *CONVEMAR* made Set No. 10.

Set No. 10 was made at 15:30 hr at 18°21'N and 105°06'W, but it was too late in the day to carry out full-scale tagging and tracking. Approximately 30 eastern spinner dolphins, *Stenella longirostris orientalis* and 60-90 spotted dolphins, *Stenella attenuata* [northeastern offshore] were captured. Underwater video recordings were made of activity inside the net. A bubble-curtain experiment was done by PNAAPD scientists. The dolphin-safe jet-boat ended up at the apex of the backdown channel during backdown. This confused the humans and dolphins inside the net. Dolphin rescue personnel (Armstrong, Bratten, and Scott) had to cut PSP webbing at the apex to release a pair of spinner dolphins entangled in a net fold.

26 November 1993
(Noon Position: 18°25'N and 104°16'W)

Daily Activities:

Marine mammal search began at 06:20 hr and the starting position was 18°29'N and 104°22'W. A seabird flock composed of approximately 50-70 brown and red-footed boobies and one frigate bird was sighted over a school of dolphins from the *McARTHUR* at 06:43 hr (Sighting No. 79: *Stenella attenuata* [northeastern offshore] 18°29'N and 104°22'W). The helicopter reported some small tuna feeding at the surface near some of the seabirds, and approximately 250 dolphins with scattered tuna "jumpers". The

CONVEMAR made Set No.11 on this school at 08:03 hr.

Set No. 11 was made at 18°25'N and 104°14'W. Over half of the 250 dolphins evaded the set. Approximately 120 dolphins were inside the net at the end of encirclement and an estimated six to eight tons of yellowfin tuna was captured. A full-scale tagging and tracking operation ensued and underwater video footage was recorded. Armstrong and Bratten were instructed to enter the net to acclimatize the dolphins to our presence. When the net was rolled to the tie-down marker, Armstrong and Bratten hand-captured a 196-cm, fused, female spotted dolphin (D-9) and delivered it to the dolphin tagging personnel.

D-9 was tagged with a radio-transmitter/TDR package broadcasting at 148.370 MHz and released inside the net. The NOAA dive team was positioned on the floor of the net while D-9 was being tagged and they attempted to tag tuna with lances. They were unsuccessful because of at least two factors. One was the small amount of tuna captured during the set and the other was avoidance behavior by tuna in the expansive open area of the net. Divers encumbered with scuba gear could not move fast enough to approach tuna and apply the tag. The tuna-tagging strategy changed after the dolphin was tagged and released.

Tagging lances were given to skin divers, who positioned themselves at the apex of the backdown channel (Armstrong), and about 1/3 of the distance up the backdown channel (Bratten) where the net was shallow during the early stages of backdown. Two 60-80 lb yellowfin tuna (T-3 and T-4) were tagged using the lances. T-3 was tagged with a V7P: 50 KHz depth sensitive transmitter and T-4 was tagged with a V3: 60 KHz pinger. T-3 was tagged on the dorsal surface posterior and to the left of the dorsal fin. It exited the net shortly after the dolphins were released during backdown. T-4 was not seen leaving the net and its sonic-transmitter signal was not detected outside of the net (Holland and Olson focused their efforts on T-3). The primary tuna tracking launch (AR-4) had a fuel-line problem just as the tuna exited the net so early tuna tracking was done exclusively from the AR-3. T-3 was tracked for approximately one hour before the signal was lost at 11:30 hr.

Armstrong and García were relocated to the CONVEMAR at 11:00 hr to assist Bratten with dolphin tracking. Both ships concentrated on dolphin tracking. At 16:00 hr the helicopter checked a school of dolphins associated with D-9. The fish spotter reported 200-300 "spotters", a bird flock, and yellowfin tuna "*shiners*". D-9 was tracked all night from both ships.

27 November 1993

(Noon Position: 18°37'N and 104°00'W)

Daily Activities:

At sunrise, personnel on both ships were still tracking D-9. A mixed school of spotted and spinner dolphins was sighted from the McARTHUR at 08:00 hr (Sighting No. 80: *Stenella attenuata* [northeastern offshore] and *Stenella longirostris orientalis* 18°29'N and

104°16'W). Personnel aboard the *McARTHUR* reported seeing a flock of 50-60 seabirds and a mixed school of spotted and spinner dolphins in the area in which the radio-tracking gear indicated D-9 was located.

At 11:21 hr, the helicopter found a widely scattered school of about 500 spotted dolphins that was carrying tuna (Sighting No. 81: *Stenella attenuata* [northeastern offshore], *Stenella longirostris orientalis* 18°30'N and 104°08'W). Scott temporarily suspended tracking D-9 to make a set on this school. A mixed school of approximately 70 "spotters and bottlenose" dolphins was sighted from the helicopter (Sighting No. 82: "*Spotters and Bottlenose dolphins*" 18°31'N and 104°08'W) at 11:27 hr and an additional sighting of "dolphins and no birds" was reported from the helicopter at 12:17 hr (Sighting No. 83: "Dolphins" 18°37'N and 104°00'W). In Set No. 12 on the dolphins from Sighting No. 81, approximately half of the dolphins in the school evaded capture prior to encirclement. All of the spinner dolphins in the school escaped under the 1/2-net marker or evaded across the bow of the purse-seine vessel.

I was aboard the *CONVEMAR* as it made Set No. 12 at 13:18 hr at 18°35'N and 103°56'W. I entered the net at "*rings up*" to help Bratten look for tuna. Approximately 300 spotted dolphins had been captured. Members of the tagging and tracking team made preparations to perform full-scale tagging and tracking, but this was canceled by Scott after being informed that only 14 yellowfin tuna were captured. Underwater video was taken of the activity inside the net during backdown. After the set was completed, I returned to the *McARTHUR* and both vessels travelled to the area where D-9's signal had last been detected. As soon as the signal was detected, tracking of D-9 resumed on the *McARTHUR*.

28 November 1993
(Noon Position: 18°28'N and 104°17'W)

Daily Activities:

At 06:00 hr D-9 was still being tracked. The *McARTHUR*'s position was 18°32'N and 104°06'W. D-9's school was sighted on the 25X glasses from the *McARTHUR* at 07:25 hr (Sighting No. 84: *Stenella attenuata* [northeastern offshore] 18°34'N and 104°05'W). D-9 was identified in this school of 400-500 spotted dolphins travelling low under a flock of 30-50 jaegers, terns, and brown boobies. Scott instructed Captain Cervantes to make a set on this school.

Set No. 13, on D-9's school was made at 07:55 hr and the ship's position was 18°34'N and 104°07'W. D-9, however, evaded capture during encirclement by lingering alone at the rear of the school and going out the opening between the bow of the seiner and the speedboats after the net was deployed. Approximately 300 spotted dolphins were captured. A bubble-curtain experiment was completed by PNAAPD scientists and underwater video footage was made during the set. A two-tone calf was observed with a plastic six-pack holder wrapped around its beak inside the net (video was recorded). An estimated five tons of yellowfin tuna was brailed aboard the seiner.

A group of five to ten rough-toothed dolphins were sighted from the *McARTHUR* (Sighting No. 85: *Steno bredanensis* 18°29'N and 104°12'W) at 10:57 hr. This tightly assembled school of dolphins was observed lob-tailing, porpoising, slow-rolling, and making random movements as if feeding.

Set No. 14 was made on D-9's school at 12:07 hr but was a skunk set. The ship's position was 18°28'N and 104°17'W when the net was deployed. D-9 evaded capture once again, this time during the encirclement, by diving under the 1/2-net marker. Once captain Cervantes was aware that D-9 had evaded the set he called the speedboats back to the *CONVEMAR* so the dolphins could escape from the seine through the opening between the bow of the purse-seine vessel and the net skiff. Tracking of D-9 was resumed on the *McARTHUR* at 12:10 hr while the *CONVEMAR* pursed and rolled the empty net aboard. D-9 was tracked all night.

29 November 1993

(Noon Position: 18°25'N and 104°17'W)

Daily Activities:

Scientific personnel aboard the *McARTHUR* were tracking D-9 at 06:00 hr at 18°34'N and 104°08'W. An attempt to capture D-9 was made at 09:17 hr when Set No. 15 was made at 18°26'N and 104°17'W. Eight spotted dolphins were captured, but D-9 evaded the set again. A net roll-up occurred during the set so the *McARTHUR* resumed tracking while the roll-up was cleared. A group of three to four rough-toothed dolphins was observed slow-rolling near the ship at 09:27 hr. This sighting was not assigned a sighting number but the sighting position was 18°28'N and 104°18'W.

The fish spotter in the helicopter located a school of 250 "spotters" at 14:31 hr (Sighting No. 86: *Stenella attenuata* [northeastern offshore] and *Delphinus delphis* [short-beak] 18°23'N and 104°07'W). A flock of approximately 20 brown boobies and a few jaegers and terns was noted associated with the school. This school did not contain D-9, but a set was made because the fish spotter had reported tuna.

Set No. 16 was made at 14:59 hr on a mixed school of 250 spotted and common dolphins at 18°23'N and 104°06'W. Most of the school evaded the set prior to encirclement except for 14 spotted dolphins and one small common dolphin. Underwater video footage was taken of activity inside the net. A 200-cm, fused, male spotted dolphin (D-10) was hand-captured and delivered to the dolphin-tagging personnel. A radio-transmitter/TDR package tuned to 148.300 KHz was attached to the dorsal fin of D-10 and it was released inside the net. No tuna were captured during the set.

Armstrong and García were moved to the *CONVEMAR* to assist Bratten with night tracking efforts of D-10 while the *McARTHUR* tracked D-9. The two ships became separated by more than 24 miles during the night, but early in the morning both of the dolphins were fairly close to each other, albeit not in the same schools (signals from both dolphins were detected in the same general area but the tracking equipment indicated they

were in different schools).

30 November 1993
(Noon Position: 18°22'N and 104°12'W)

Daily Activities:

While Armstrong and García continued to assist Bratten with dolphin tracking aboard the *CONVEMAR*, the helicopter found a mixed school of 200 spotted and spinner dolphins at 11:33 hr. The fish spotter reported tuna were associated with 30 dolphins at the front of the school. There was no sighting number or position assigned to this school. The net was deployed on this school for Set No. 17 at 11:33 hr. The *CONVEMAR*'s position when the skiff was released was 18°22'N and 104°12'W. About 20-25 spotted dolphins, *Stenella attenuata* [northeastern offshore] and 21 eastern spinner dolphins, *Stenella longirostris orientalis*, and five to eight tons of predominantly small, 15-25-lb yellowfin tuna were captured. Underwater video footage of activities inside the net was taken.

When the net had been rolled to the tie-down buoy, Armstrong and Bratten hand-captured a 175-cm, male, mottled, spotted dolphin (D-11) and brought it to the tagging rafts. Chivers and Rhinehart attached a radio-transmitter tag tuned to 148.319 MHz to the dorsal fin and released the dolphin inside the net. Armstrong and Bratten positioned themselves near the apex of the backdown channel with tuna-tagging gear and waited for an opportunity to lance-tag tuna during backdown. Two 20-25-lb yellowfin tuna (T-5 and T-6) were tagged. T-5 was tagged with a V3P: 60 KHz depth sensitive transmitter with an effective transmitting range of 0.5 - 0.75 nm, and T-6 was tagged with a V3: 71 KHz sonic-pinger) during backdown. Neither of the tagged tuna were released from the net with the dolphins during backdown. Tuna tracking personnel could hear T-5's transmitter inside the net after backdown had been completed.

Tracking tuna was the highest priority at this point of the cruise so two speedboats were attached to the corkline, after backdown was completed, and they towed on the net to prevent a net collapse. If the net had collapsed, it would have killed the tuna that remained in the net. The bow ortza was slackened and an opening formed between the seiner and the net-webbing which provided an escape route for the tuna remaining in the net. After T-5 was liberated, it was tracked by scientists aboard AR-4 and AR-2¹. After the tuna were released, Scott and Rhinehart boarded the *CONVEMAR* with Armstrong and García. The *CONVEMAR* moved to the last known position of D-9 as soon as the net skiff was secured aboard. The *McARTHUR* and its tracking launches followed T-5.

We located D-9's signal with the radio-tracking gear and spotted a flock of seabirds and a spotted dolphin school where the tracking equipment indicated the tagged dolphin should be. The helicopter was sent to check the school of dolphins under the seabirds. The fish

¹The AR-2 was outfitted with a hydrophone so tuna tracking could be done in less than optimal conditions for launching and recovering the AR-4 or AR-3.

spotter located D-9 in the school. The fish spotter located D-9 and directed the set to be made exclusively on D-9 and one other spotted dolphin that were located at the rear of the main school. Both dolphins were captured.

Set No. 18 was made at 16:30 hr and the position was 18°17'N and 104°13'W. Armstrong and Bratten entered the net at "rings up" with a raft and skin diving gear. Scott and Rhinehart entered the net with the tagging raft and gear, when the 1/2-net marker was rolled aboard, and they moved toward Armstrong and Bratten. Armstrong and Bratten hand-captured D-9 and conveyed her to Scott and Rhinehart's raft. Scott and Rhinehart removed the tag and D-9 was released outside of the seine, but a backdown maneuver was executed to release the other spotted dolphin. Underwater video of activities inside the net was taken. After the set was completed, the tracking gear was disassembled and packed for transfer to the *McARTHUR*. Armstrong, García, Rhinehart, and Scott were transferred from the *CONVEMAR* to the *McARTHUR* via the AR-4 at 19:34 hr. T-5's signal was lost at 22:18 hr and tuna tracking was terminated. The *McARTHUR* returned to the area where D-11's signal had been last detected to obtain a final position.

1 December 1993

Daily Activities:

D-11's signal was located at 00:00 hr with radio-tracking gear and a final position was recorded (18°19'N and 104°11'W). Search effort utilizing radio-tracking equipment was switched to D-10. D-10's signal was located at 01:15 hr and its final position was recorded (18°23'N and 104°20'W). With dolphin-tuna tagging operations completed, the *McARTHUR* headed for San Diego.

2 December - 5 December 1993

Daily Activities:

The remainder of the trip was spent in transit to San Diego. Equipment was disassembled, cleaned, inventoried, and packed. The *McARTHUR* arrived in San Diego at 08:00 hr on 5 December 1993.

TUNA-DOLPHIN TRACKING STUDY: 1993

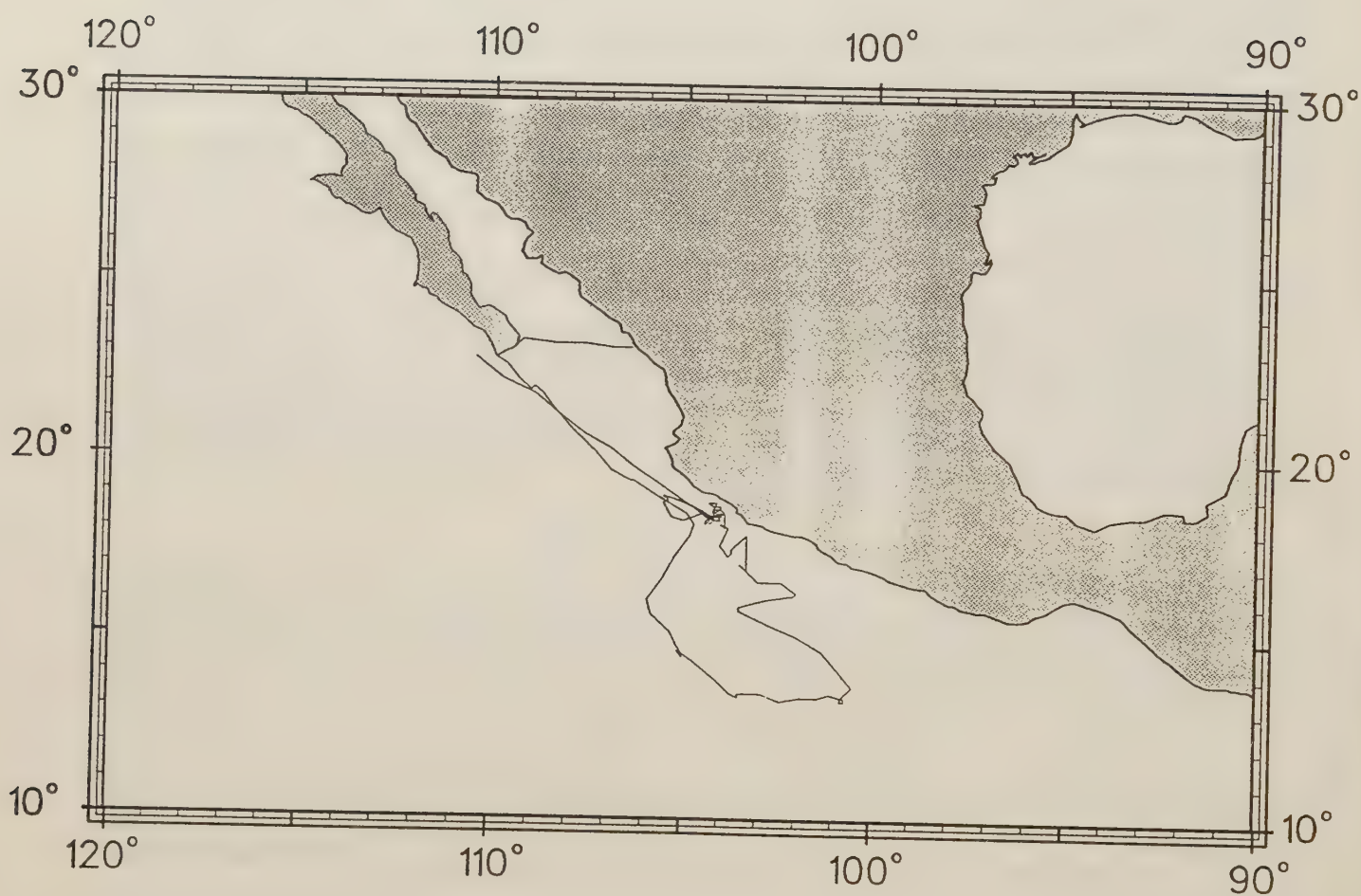


FIGURE 1. Map of the Tuna-Dolphin Tracking Study.

TABLE 1. SUMMARY OF SETS MADE DURING THE 1993 DOLPHIN-TUNA TAGGING AND TRACKING STUDY

SET NO.	DATE	LAT. N	LONG. W	RESEARCH ACTIVITIES
1	11/09/93	22°11'N	109°56'W	Skunk Set
2	11/10/93	19°27'N	106°24'W	Dive team observed backdown procedure inside net.
3	11/15/93	13°32'N	101°11'W	Tagging operation was aborted due to steering failure on AR-4. PNAAPD scientists conducted acoustic recording study.
4	11/19/93	17°48'N	103°30'W	(D-7) 191-cm, fused, male, spotted dolphin tagged with a radio-transmitter tag integrated with a TDR transmitting at 148.300 MHz. D-7 tracked for 18.5 hours. PNAADP acoustic recordings. (Video)
5	11/20/93	17°21'N	103°52'W	TDR recovered from D-7. (Video)
6	11/20/93	17°05'N	103°55'W	PNAAPD Bubble-Curtain experiment video taped. Too late to conduct tagging operations.
7	11/21/93	18°34'N	103°58'W	A fused, 198-cm, female, spotted dolphin (D-8) was tagged with a radio-transmitter/TDR package. D-8 was tracked for 49 hours. Two 60-lb yellowfin tuna (T-1 and T-2) were tagged with sonic-transmitters T-1: V7P: 50 KHz depth-sensitive transmitter and T-2 was tagged with a V3: 60 KHz sonic-pinger. T-1 was tracked for 31 hours. (Video)
8	11/23/93	18°37'N	104°02'W	Recovered TDR from D-8. Purse cable parted and tagging operations were canceled.

9	11/25/93	18°53'N	105°32'W	Tagging operations were canceled because of the high proportion of cow/calf pairs captured. PNAAPD scientists conducted bubble-curtain experiment. (Video)
10	11/25/93	18°21'N	105°06'W	The set was made after the cut-off time so no tagging operations were conducted. The PNAAPD scientists conducted a bubble-curtain experiment. (Video)
11	11/26/93	18°25'N	104°14'W	A fused, 196-cm, female, spotted dolphin (D-9) was tagged with a radio-transmitter/TDR package. It was tracked for 4.25 days. Two 60-80 lb yellowfin tuna (T-3 and T-4) were tagged. T-3 was tagged with a V7P: 50 KHz depth sensitive transmitter and T-4 was tagged with a V3: 60 KHz pinger. T-3 was tracked for approximately one hour before the signal was lost. (Video)
12	11/27/93	18°35'N	103°56'W	No tagging operations were conducted because only 14 yellowfin tuna were captured. The backdown procedure was recorded on video tape.
13	11/28/93	18°34'N	104°07'W	Dolphin D-9 evaded the set. A bubble-curtain experiment was performed by PNAAPD scientists and underwater video footage was recorded during the set. A two-tone calf was observed with a plastic six-pack holder wrapped around its beak. (Video)
14	11/28/93	18°28'N	104°17'W	It was a skunk set. D-9 evaded the set during encirclement by diving under the 1/2-net marker.
15	11/29/93	18°26'N	104°17'W	Eight spotted dolphins were captured, but D-9 evaded the set.

16	11/29/93	18°23'N	104°06'W	A 200-cm, fused, male spotted dolphin (D-10) was tagged with a radio-transmitter/TDR package. It was tracked for 32 hours. (Video)
17	11/30/93	18°22'N	104°12'W	A 175-cm, male, mottled, spotted dolphin (D-11) was tagged with a radio-transmitter tag. It was tracked for 11 hours. Two 20-25-lb yellowfin tuna (T-5 and T-6) were tagged. T-5 was tagged with a V3P: 60 KHz depth sensitive transmitter and T-6 was tagged with a V3: 71 KHz sonic-pinger. T-5 was tracked for 8 hours. (Video)
18	11/30/93	18°17'N	104°13'W	TDR recovered from D-9.

TABLE 2. SUMMARY OF CETACEAN SIGHTINGS

SIGHTING NUMBER	DATE	SPECIES	POSITION
1	11/09/93	<i>Grampus griseus</i>	18°35'N and 105°02'W
2	11/09/93	<i>Steno bredanensis</i>	18°24'N and 104°50'W
3	11/09/93	<i>Ziphius cavirostris</i>	18°16'N and 104°42'W
4	11/12/93	"Spotters"	15°44'N and 105°53'W
5	11/12/93	"Spotters"	15°28'N and 105°46'W
6	11/13/93	<i>Stenella attenuata</i> (NE offshore)	14°36'N and 104°57'W
7	11/13/93	<i>Stenella attenuata</i> (NE offshore) <i>Tursiops truncatus</i>	14°15'N and 104°38'W
8	11/13/93	"Spotters"	14°13'N and 104°35'W
9	11/13/93	"Spotters"	13°59'N and 104°13'W
10	11/13/93	<i>Stenella attenuata</i> (NE offshore) <i>Stenella longirostris orientalis</i>	13°50'N and 104°01'W
11	11/14/93	Unidentified dolphins	13°34'N and 103°15'W
12	11/14/93	<i>Stenella longirostris orientalis</i>	13°30'N and 102°50'W
13	11/14/93	Spotters and Spinners	13°24'N and 102°46'W
14	11/14/93	<i>Stenella attenuata</i> (NE offshore) <i>Stenella longirostris orientalis</i>	13°20'N and 102°33'W
15	11/14/93	"Spotters"	13°26'N and 102°09'W
16	11/15/93	<i>Stenella attenuata</i> (NE offshore) <i>Stenella longirostris orientalis</i>	13°25'N and 101°35'W
17	11/15/93	"Porpoise"	13°27'N and 101°30'W
18	11/15/93	<i>Stenella attenuata</i> (NE offshore) <i>Stenella longirostris orientalis</i> <i>Tursiops truncatus</i>	13°31'N and 101°10'W
19	11/15/93	<i>Stenella longirostris orientalis</i>	13°35'N and 101°08'W
20	11/15/93	"Spotters"	13°36'N and 101°03'W
21	11/15/93	<i>Stenella attenuata</i> (NE offshore)	13°31'N and 100°53'W
22	11/16/93	<i>Stenella attenuata</i> (NE offshore)	13°24'N and 100°42'W
23	11/16/93	<i>Stenella attenuata</i> (NE offshore) <i>Stenella longirostris orientalis</i>	13°23'N and 100°42'W

SIGHTING NUMBER	DATE	SPECIES	POSITION
24	11/16/93	<i>Stenella attenuata</i> (NE offshore)	14°12'N and 100°50'W
25	11/16/93	<i>Stenella longirostris orientalis</i> "Porpoise"	14°21'N and 101°01'W
26	11/16/93	<i>Stenella attenuata</i> (NE offshore)	14°25'N and 101°03'W
27	11/16/93	"Spotters"	14°27'N and 101°06'W
28	11/16/93	<i>Stenella attenuata</i> (NE offshore)	14°31'N and 101°08'W
29	11/16/93	<i>Stenella attenuata</i> (NE offshore)	14°31'N and 101°08'W
30	11/17/93	<i>Stenella longirostris orientalis</i> <i>Stenella attenuata</i> (NE offshore)	15°56'N and 103°45'W
31	11/17/93	<i>Grampus griseus</i> Unidentified dolphins	15°59'N and 103°10'W
32	11/17/93	<i>Stenella attenuata</i> (NE offshore)	15°59'N and 103°10'W
33	11/17/93	<i>Stenella longirostris orientalis</i> "Spotters"	15°01'N and 103°00'W
34	11/17/93	<i>Stenella attenuata</i> (NE offshore)	16°08'N and 102°44'W
35	11/17/93	<i>Stenella longirostris orientalis</i>	16°04'N and 102°37'W
36	11/17/93	<i>Steno bredanensis</i>	16°04'N and 102°36'W
37	11/18/93	<i>Stenella longirostris orientalis</i>	16°35'N and 102°20'W
38	11/18/93	<i>Stenella attenuata</i> (NE offshore)	16°48'N and 102°35'W
39	11/18/93	<i>Stenella longirostris orientalis</i> <i>Balaenoptera musculus</i>	16°51'N and 102°39'W
40	11/18/93	<i>Grampus griseus</i>	16°48'N and 102°46'W
41	11/18/93	"Spotters"	16°48'N and 102°47'W
42	11/18/93	<i>Steno bredanensis</i> <i>Tursiops truncatus</i>	16°46'N and 102°49'W
43	11/18/93	"Spotters and Spinners"	16°40'N and 103°02'W
44	11/18/93	<i>Steno bredanensis</i>	16°48'N and 103°26'W
45	11/19/93	"Spotters"	17°30'N and 103°19'W
46	11/19/93	<i>Steno Bredanensis</i>	17°36'N and 103°19'W
47	11/19/93	<i>Grampus griseus</i>	17°37'N and 103°15'W
48	11/19/93	<i>Stenella attenuata</i> (NE offshore)	17°37'N and 103°13'W

SIGHTING NUMBER	DATE	SPECIES	POSITION
49	11/19/93	<i>Stenella attenuata</i> (NE offshore)	17°52'N and 103°23'W
50	11/20/93	<i>Ziphius cavirostris</i>	17°20'N and 103°49'W
51	11/20/93	<i>Stenella attenuata</i> (NE offshore)	17°25'N and 104°03'W
52	11/20/93	<i>Stenella longirostris orientalis</i> <i>Stenella attenuata</i> (stock undetermined)	17°26'N and 104°05'W
53	11/20/93	<i>Stenella longirostris orientalis</i> "Spotters"	17°37'N and 104°05'W
54	11/20/93	<i>Stenella attenuata</i> (NE offshore)	17°49'N and 104°00'W
55	11/21/93	<i>Stenella longirostris orientalis</i> <i>Tursiops truncatus</i> <i>Stenella attenuata</i> (NE offshore)	18°13'N and 103°54'W
56	11/21/93	<i>Stenella attenuata</i> (NE offshore)	18°15'N and 103°54'W
57	11/21/93	<i>Delphinus delphis</i> (short-beak)	18°19'N and 103°55'W
58	11/21/93	<i>Steno bredanensis</i>	18°21'N and 103°59'W
59	11/21/93	<i>Stenella attenuata</i> (NE offshore)	18°22'N and 103°59'W
60	11/21/93	<i>Steno bredanensis</i>	18°23'N and 103°59'W
61	11/21/93	Unidentified Ziphid sp.	18°30'N and 104°00'W
62	11/21/93	<i>Stenella attenuata</i> (stock undetermined)	18°36'N and 104°07'W
63	11/21/93	<i>Stenella attenuata</i> (NE offshore)	18°36'N and 104°08'W
64	11/21/93	<i>Megaptera novaeangliae</i>	18°37'N and 104°08'W
65	11/22/93	unidentified cetacean	18°50'N and 104°21'W
66	11/22/93	unidentified cetacean	18°51'N and 104°21'W
67	11/22/93	unidentified cetacean	18°51'N and 104°21'W
68	11/22/93	unidentified cetacean	18°49'N and 104°19'W
69	11/24/93	<i>Grampus griseus</i>	18°40'N and 104°40'W
70	11/24/93	<i>Stenella attenuata</i> (NE offshore)	18°47'N and 104°47'W
71	11/24/93	<i>Steno bredanensis</i>	18°51'N and 104°48'W
72	11/24/93	<i>Tursiops truncatus</i>	18°55'N and 105°11'W

SIGHTING NUMBER	DATE	SPECIES	POSITION
73	11/25/93	<i>Stenella attenuata</i> (NE offshore)	18°53'N and 105°28'W
74	11/25/93	"Spotters"	18°45'N and 105°35'W
75	11/25/93	"Spinners"	18°43'N and 105°35'W
76	11/25/93	<i>Stenella sp.</i>	18°38'N and 105°28'W
77	11/25/93	<i>Tursiops truncatus</i> <i>Grampus griseus</i>	18°36'N and 105°27'W
78	11/25/93	<i>Stenella attenuata</i> (NE offshore) <i>Stenella longirostris orientalis</i>	18°21'N and 105°21'W
79	11/26/93	<i>Stenella attenuata</i> (NE offshore)	18°29'N and 104°22'W
80	11/27/93	<i>Stenella attenuata</i> (NE offshore) <i>Stenella longirostris orientalis</i>	18°29'N and 104°16'W
81	11/27/93	<i>Stenella attenuata</i> (NE offshore) <i>Stenella longirostris orientalis</i>	18°30'N and 104°08'W
82	11/28/93	<i>Stenella attenuata</i> (NE offshore)	18°34'N and 104°05'W
83	11/28/93	"Dolphins"	18°37'N and 104°00'W
84	11/28/93	<i>Stenella attenuata</i> (NE offshore)	18°34'N and 104°05'W
85	11/28/93	<i>Steno bredanensis</i>	18°29'N and 104°12'W
86	11/29/93	<i>Stenella attenuata</i> (NE offshore) <i>Delphinus delphis</i> (short-beak)	18°23'N and 104°07'W

TABLE 3. PROJECTILE BIOPSY SAMPLE DATA FROM THE 1993 DOLPHIN-TUNA TRACKING STUDY ABOARD THE NOAA SHIP *McARTHUR*

Sample No.	Sighting No.	Species	Position	Shots/Sample
30	2	<i>Steno bredanensis</i>	18°24'N 104°50'W	1/1
31	62	<i>Stenella attenuata</i>	18°36'N 104°47'W	1/1
32	62	<i>Stenella attenuata</i>	18°36'N 104°47'W	1/1
34	78	<i>Stenella attenuata</i>	18°21'N 105°21'W	1/1
34	78	<i>Stenella attenuata</i>	18°21'N 105°21'W	1/1

*I made three attempts to collect samples from Eastern spinner dolphins during sighting number 35 on 17 November 1993. I hit two dolphins but no samples were collected.

APPENDIX I

SCIENTIFIC PERSONNEL:

Chief Scientist: Dr. Michael Scott, IATTC
Cruise Coordinator: Charles W. Oliver, SWFSC

Dolphin-Tuna Tracking Study Personnel *McARTHUR*

<u>NAME</u>	<u>POSITION</u>	<u>ORGANIZATION</u>
1. Dr. Michael Scott	Chief Scientist	IATTC
2. Dr. Robert Olson	Scientist	IATTC
3. Dr. Susan Chivers	Scientist/ NMFS Cruise Leader	SWFSC
4. Dr. Kim Holland	Scientist	UH
5. Wesley Armstrong	Scientist	SWFSC
6. Marco García	Scientist	IATTC
7. Howard Rhinehart	Scientist	IATTC
8. Gabriel Galdana	Scientist	PNAAPD
9. Jenny Asch	Scientist	UNCR

Dolphin-Tuna Tracking Study Personnel *CONVEMAR*

1. David Bratten	Scientist/ IATTC Cruise Leader	IATTC
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PNAAPD Bubble-curtain Study Personnel

1. Tomás Arizpe	Scientist	UNAM
2. Humberto Robles	Scientist	PNAAPD

SWFSC: Southwest Fisheries Science Center, NOAA

IATTC: Inter-American Tropical Tuna Commission

UH: University of Hawaii

UNCR: Universidad Nacional de Costa Rica

UNAM: Universidad Nacional Autónoma de México

PNAAPD: Programa Nacional para el Aprovechamiento del Atún y Protección de los Delfines

